FIG.1

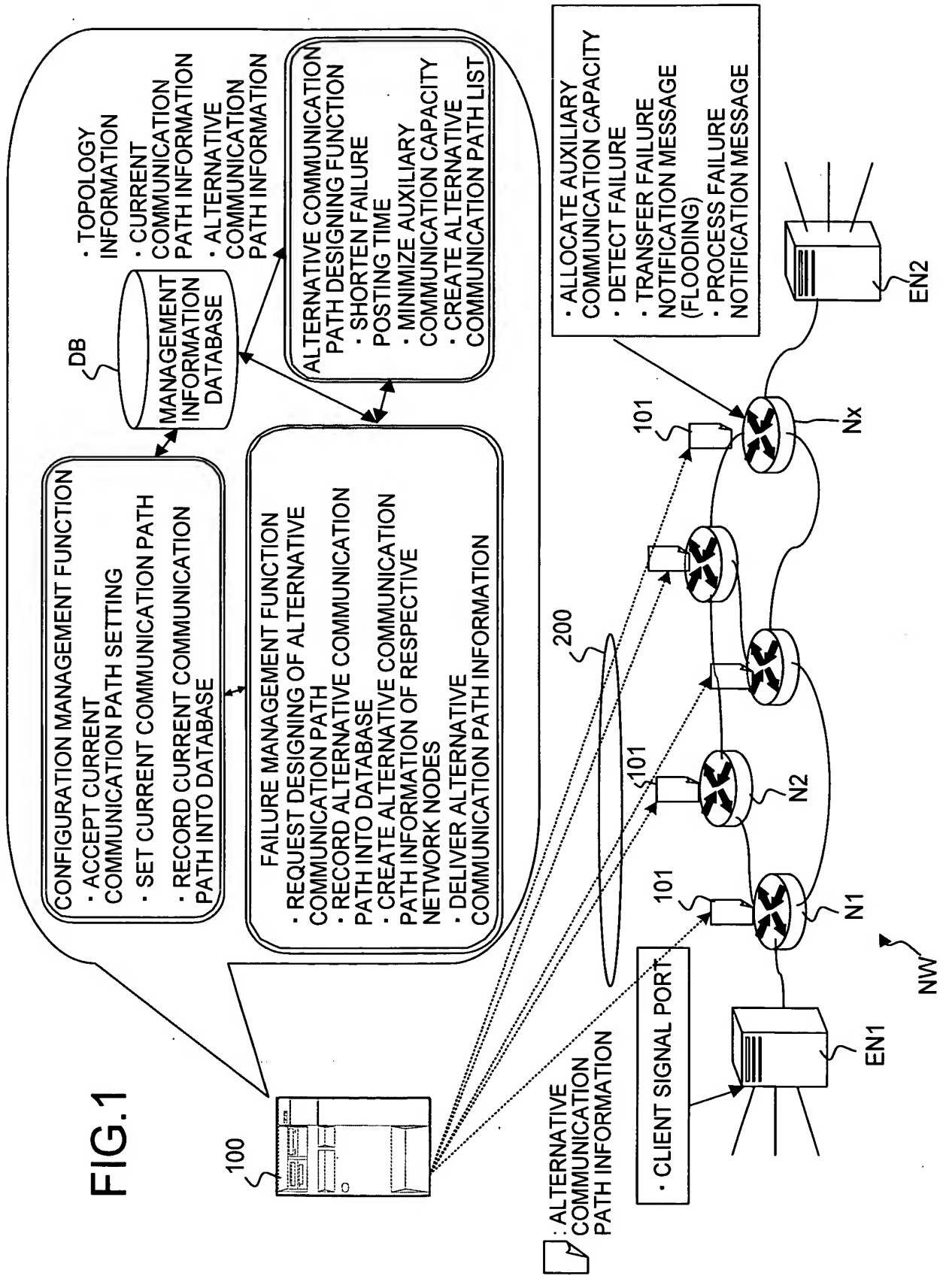

CONFIGURATION MANAGEMENT FUNCTION
· ACCEPT CURRENT COMMUNICATION PATH SETTING
· SET CURRENT COMMUNICATION PATH
· RECORD CURRENT COMMUNICATION PATH INTO DATABASE
FAILURE MANAGEMENT FUNCTION
· REQUEST DESIGNING OF ALTERNATIVE COMMUNICATION PATH
· RECORD ALTERNATIVE COMMUNICATION PATH INTO DATABASE
· CREATE ALTERNATIVE COMMUNICATION PATH INFORMATION OF RESPECTIVE NETWORK NODES
· DELIVER ALTERNATIVE COMMUNICATION PATH INFORMATION
DB
MANAGEMENT INFORMATION DATABASE
· TOPOLOGY INFORMATION
· CURRENT COMMUNICATION PATH INFORMATION
· ALTERNATIVE COMMUNICATION PATH INFORMATION
ALTERNATIVE COMMUNICATION PATH DESIGNING FUNCTION
· SHORTEN FAILURE POSTING TIME
· MINIMIZE AUXILIARY COMMUNICATION CAPACITY
· CREATE ALTERNATIVE COMMUNICATION PATH LIST
100
· ALLOCATE AUXILIARY COMMUNICATION CAPACITY
· DETECT FAILURE
· TRANSFER FAILURE NOTIFICATION MESSAGE (FLOODING)
· PROCESS FAILURE NOTIFICATION MESSAGE
200
101
Nx
N2
N1
EN1
EN2
NW
· CLIENT SIGNAL PORT
: ALTERNATIVE COMMUNICATION PATH INFORMATION

FIG.2

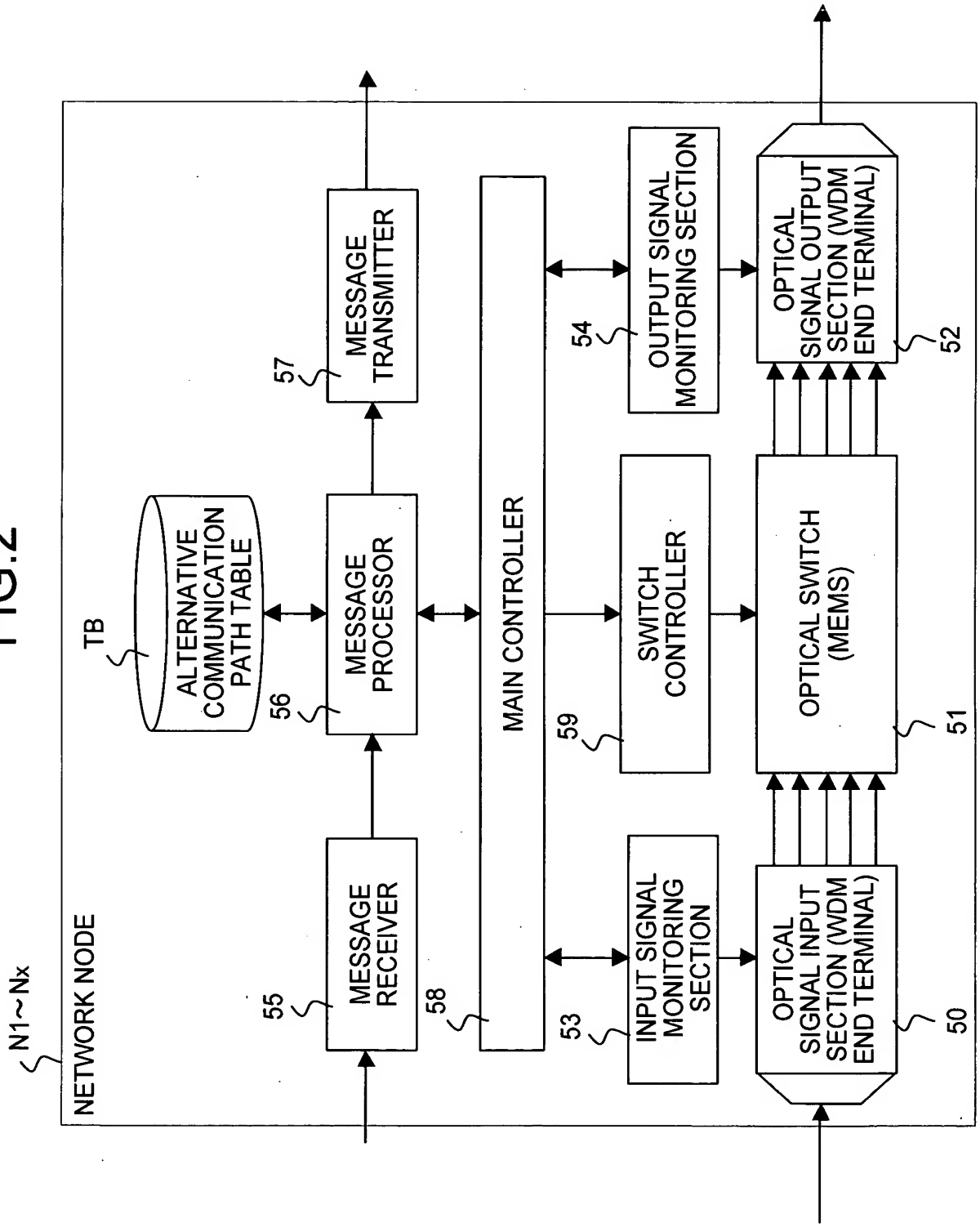

N1~Nx
NETWORK NODE
OPTICAL SIGNAL INPUT SECTION (WDM END TERMINAL)
50
OPTICAL SWITCH (MEMS)
51
OPTICAL SIGNAL OUTPUT SECTION (WDM END TERMINAL)
52
INPUT SIGNAL MONITORING SECTION
53
MAIN CONTROLLER
58
OUTPUT SIGNAL MONITORING SECTION
54
SWITCH CONTROLLER
59
MESSAGE RECEIVER
55
MESSAGE PROCESSOR
56
MESSAGE TRANSMITTER
57
TB
ALTERNATIVE COMMUNICATION PATH TABLE

FIG.3

TB

FAILURE PORTIONFAILURE CURRENT	COMMUNICATION PATH (NODE SERIES)	ALTERNATIVE COMMUNICATION PATH (NODE SERIES)	FAILURE DETECTED COMMUNICATION NODE
LINK L1 (BETWEEN N1 AND N2)	WP1 (N1 、 N2)	SP1 (N1 、 N4 、 N5 、 N2)	N2
	WP2 (N1 、 N2 、 N3 、 N6)	SP2 (N1 、 N4 、 N5 、 N6)	N2
	WP3 (N1 、 N2 、 N5 、 N8)	SP3 (N1 、 N4 、 N7 、 N8)	N2
	WP4 (N9 、 N6 、 N3 、 N2 、N1)	SP4 (N9 、 N8 、 N7 、 N4 、N1)	N1
	WP5 (N2 、 N1 、 N4)	SP5 (N2 、 N5 、 N4)	N1
LINK L2 (BETWEEN L2 AND N3)	...	...	...

FIG.4

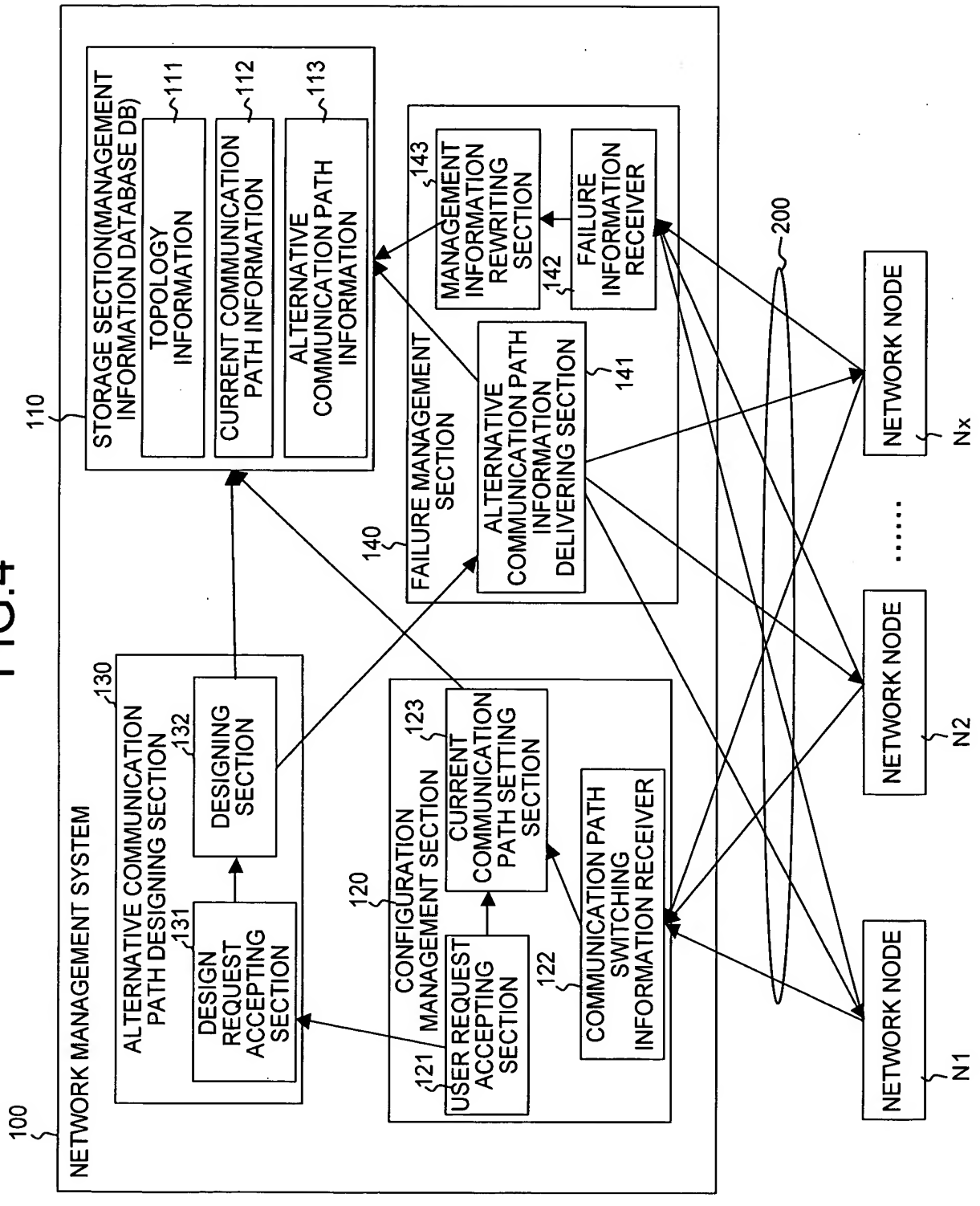

100
NETWORK MANAGEMENT SYSTEM
110
STORAGE SECTION(MANAGEMENT INFORMATION DATABASE DB)
111
TOPOLOGY INFORMATION
112
CURRENT COMMUNICATION PATH INFORMATION
113
ALTERNATIVE COMMUNICATION PATH INFORMATION
130
ALTERNATIVE COMMUNICATION PATH DESIGNING SECTION
131
DESIGN REQUEST ACCEPTING SECTION
132
DESIGNING SECTION
120
CONFIGURATION MANAGEMENT SECTION
121
USER REQUEST ACCEPTING SECTION
122
COMMUNICATION PATH SWITCHING INFORMATION RECEIVER
123
CURRENT COMMUNICATION PATH SETTING SECTION
140
FAILURE MANAGEMENT SECTION
141
ALTERNATIVE COMMUNICATION PATH INFORMATION DELIVERING SECTION
142
FAILURE INFORMATION RECEIVER
143
MANAGEMENT INFORMATION REWRITING SECTION
200
NETWORK NODE
N1
NETWORK NODE
N2
.....
NETWORK NODE
Nx

FIG.5

111

111A

NETWORK NODE	LATI-TUDE	LONGI-TUDE
N1	41.10	- 81.50
N2	33.72	- 117.90
...	...	...
Nx	47.62	- 89.97

111B

LINK	NETWORK NODE	NETWORK NODE	LENGTH (km)
L1	N1	N2	331
L2	N3	N5	185
...	...	...	...
Lx	N10	N12	169

FIG.6

112

CURRENT COMMUNICATION PATH	STARTING POINT NETWORK NODE	END POINT NETWORK NODE	ROUTE NETWORK NODE SERIES	NUMBER OF CHANNELS
W P1	N1	N3	N2	1
W P2	N2	N5	N1、N2、N3、N6	2
...	...	...	N1、N2、N5、N8	...
W Px	N10	N13	N9、N6、N3、N2、N1	1

FIG.7

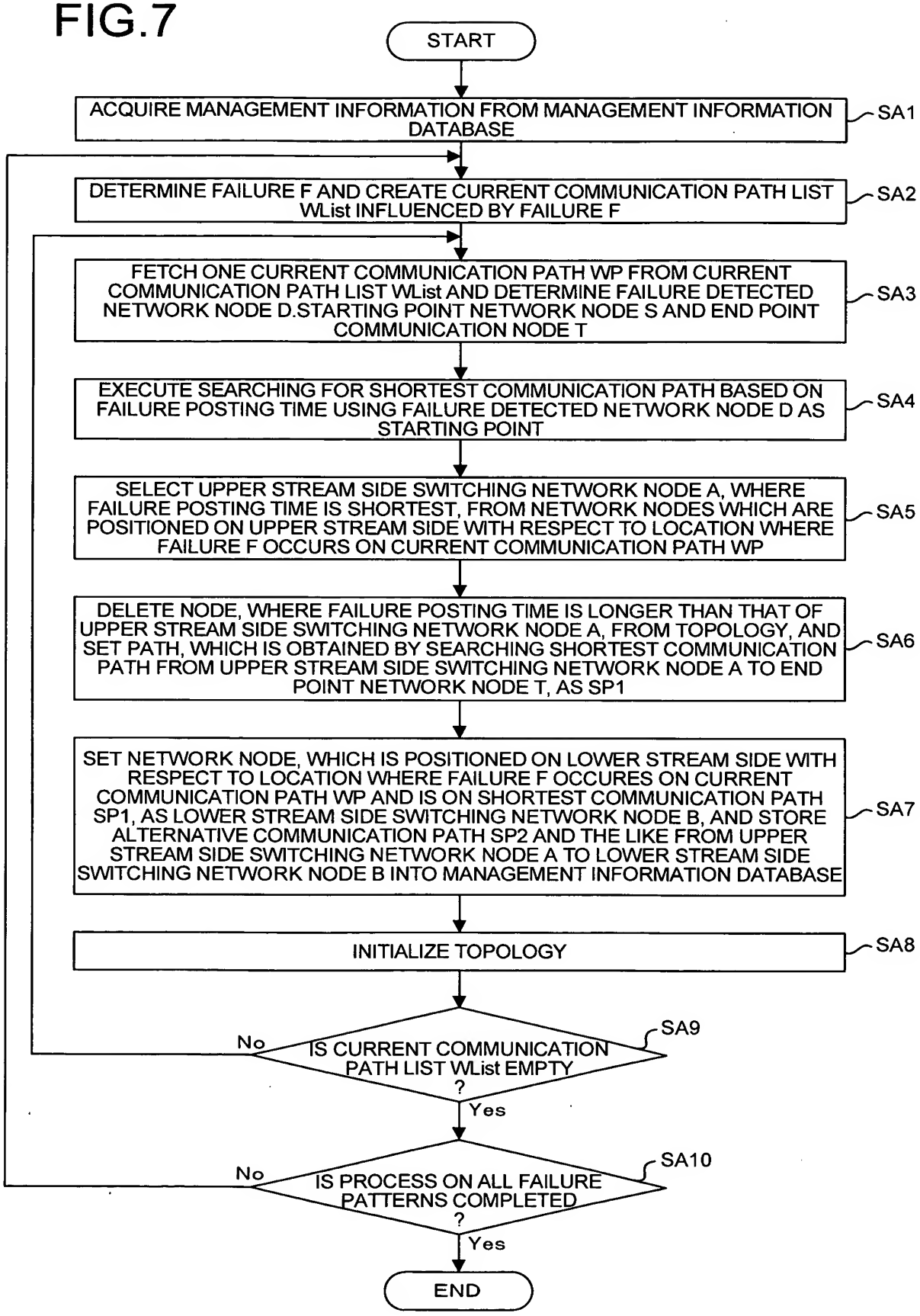
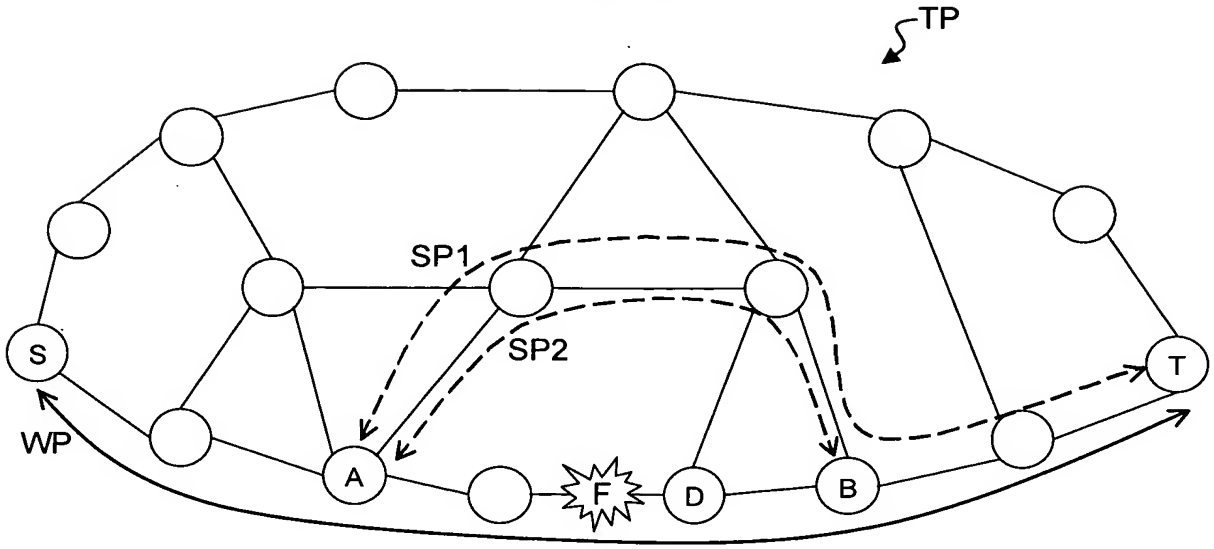

START
ACQUIRE MANAGEMENT INFORMATION FROM MANAGEMENT INFORMATION DATABASE
SA1
DETERMINE FAILURE F AND CREATE CURRENT COMMUNICATION PATH LIST WList INFLUENCED BY FAILURE F
SA2
FETCH ONE CURRENT COMMUNICATION PATH WP FROM CURRENT COMMUNICATION PATH LIST WList AND DETERMINE FAILURE DETECTED NETWORK NODE D.STARTING POINT NETWORK NODE S AND END POINT COMMUNICATION NODE T
SA3
EXECUTE SEARCHING FOR SHORTEST COMMUNICATION PATH BASED ON FAILURE POSTING TIME USING FAILURE DETECTED NETWORK NODE D AS STARTING POINT
SA4
SELECT UPPER STREAM SIDE SWITCHING NETWORK NODE A, WHERE FAILURE POSTING TIME IS SHORTEST, FROM NETWORK NODES WHICH ARE POSITIONED ON UPPER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURS ON CURRENT COMMUNICATION PATH WP
SA5
DELETE NODE, WHERE FAILURE POSTING TIME IS LONGER THAN THAT OF UPPER STREAM SIDE SWITCHING NETWORK NODE A, FROM TOPOLOGY, AND SET PATH, WHICH IS OBTAINED BY SEARCHING SHORTEST COMMUNICATION PATH FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO END POINT NETWORK NODE T, AS SP1
SA6
SET NETWORK NODE, WHICH IS POSITIONED ON LOWER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURES ON CURRENT COMMUNICATION PATH WP AND IS ON SHORTEST COMMUNICATION PATH SP1, AS LOWER STREAM SIDE SWITCHING NETWORK NODE B, AND STORE ALTERNATIVE COMMUNICATION PATH SP2 AND THE LIKE FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO LOWER STREAM SIDE SWITCHING NETWORK NODE B INTO MANAGEMENT INFORMATION DATABASE
SA7
INITIALIZE TOPOLOGY
SA8
IS CURRENT COMMUNICATION PATH LIST WList EMPTY ?
SA9
No
Yes
IS PROCESS ON ALL FAILURE PATTERNS COMPLETED ?
SA10
No
Yes
END

FIG.8



◯:NETWORK NODES N1 TO Nx

FIG.9

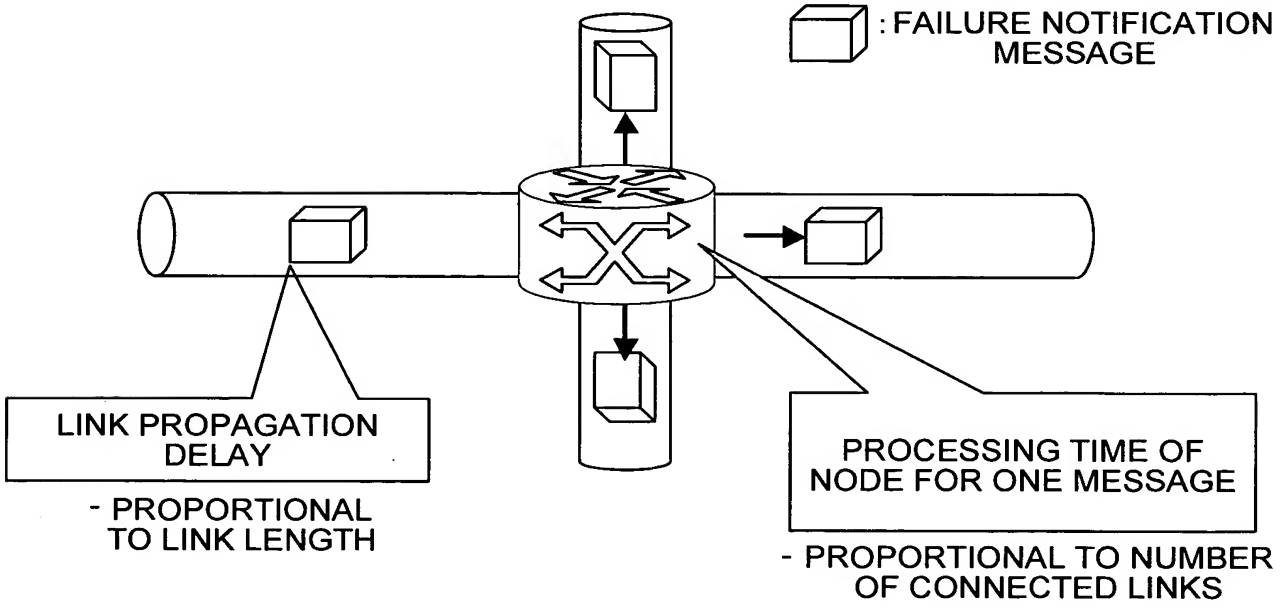


FIG.10

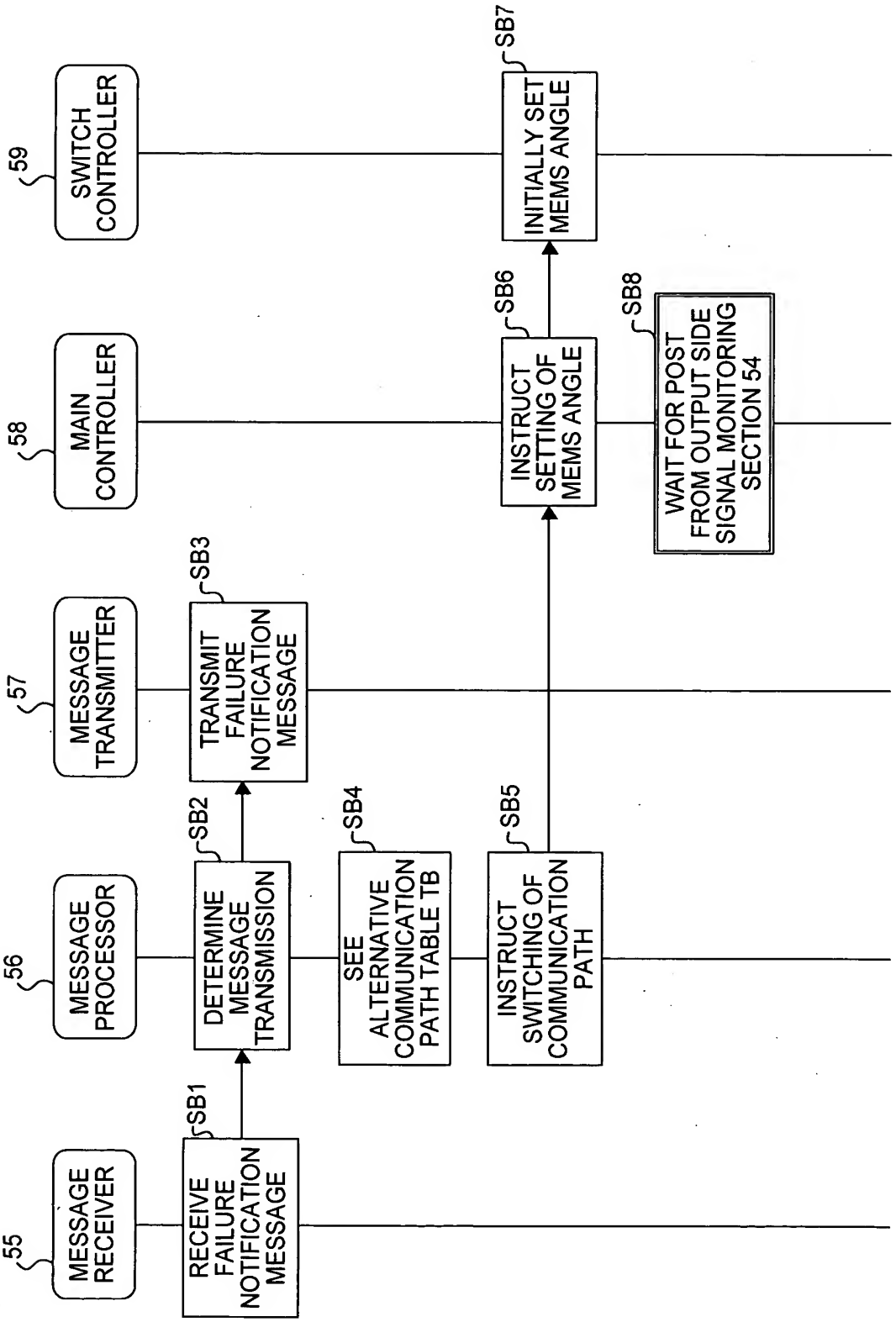

55
MESSAGE RECEIVER
RECEIVE FAILURE NOTIFICATION MESSAGE
SB1
56
MESSAGE PROCESSOR
DETERMINE MESSAGE TRANSMISSION
SB2
SEE ALTERNATIVE COMMUNICATION PATH TABLE TB
SB4
INSTRUCT SWITCHING OF COMMUNICATION PATH
SB5
57
MESSAGE TRANSMITTER
TRANSMIT FAILURE NOTIFICATION MESSAGE
SB3
58
MAIN CONTROLLER
INSTRUCT SETTING OF MEMS ANGLE
SB6
WAIT FOR POST FROM OUTPUT SIDE SIGNAL MONITORING SECTION 54
SB8
59
SWITCH CONTROLLER
INITIALLY SET MEMS ANGLE
SB7

FIG.11

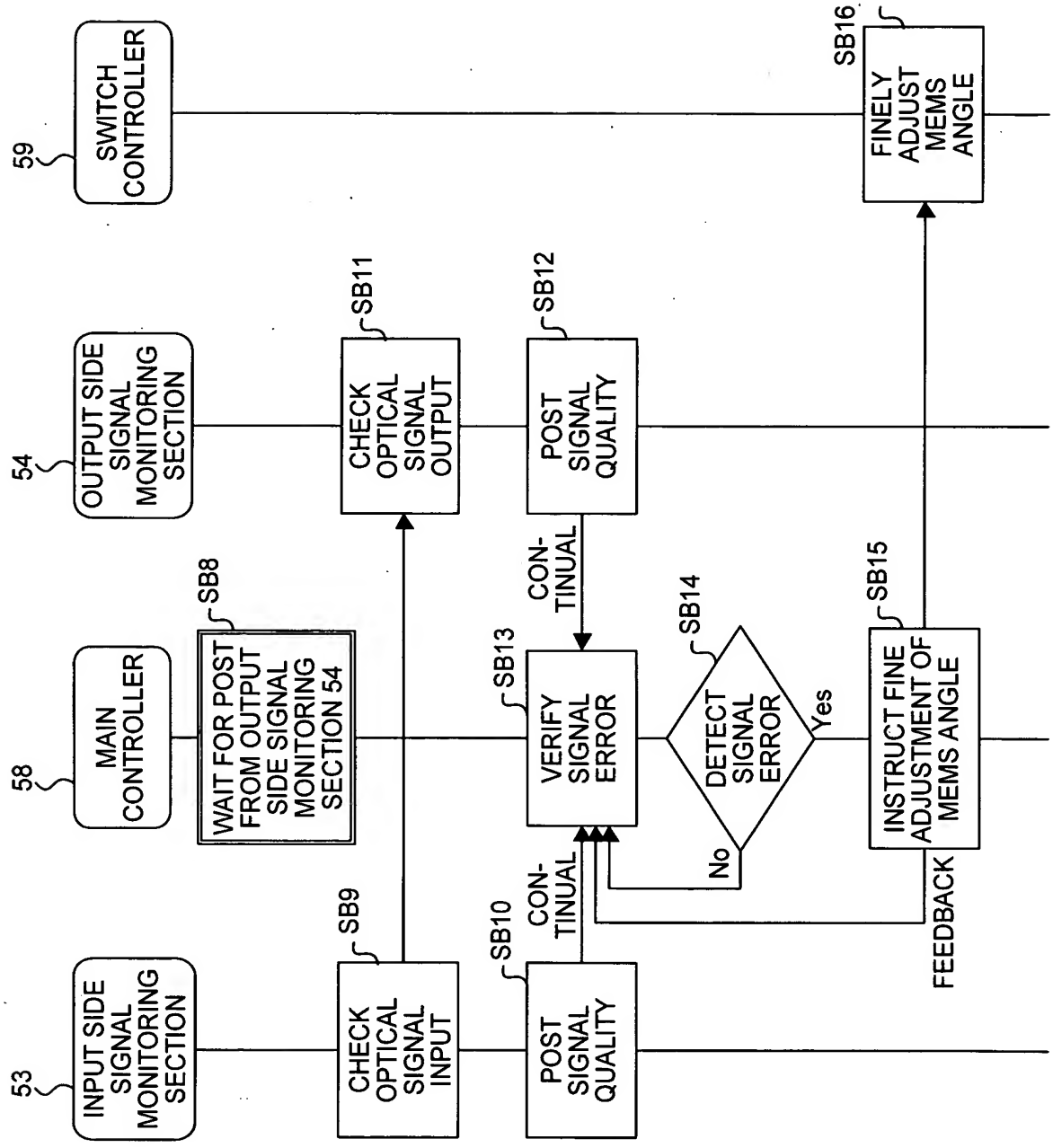

53
INPUT SIDE SIGNAL MONITORING SECTION
54
OUTPUT SIDE SIGNAL MONITORING SECTION
58
MAIN CONTROLLER
59
SWITCH CONTROLLER
CHECK OPTICAL SIGNAL INPUT
SB9
POST SIGNAL QUALITY
SB10
WAIT FOR POST FROM OUTPUT SIDE SIGNAL MONITORING SECTION 54
SB8
CHECK OPTICAL SIGNAL OUTPUT
SB11
POST SIGNAL QUALITY
SB12
CON-TINUAL
CON-TINUAL
VERIFY SIGNAL ERROR
SB13
DETECT SIGNAL ERROR
SB14
Yes
No
INSTRUCT FINE ADJUSTMENT OF MEMS ANGLE
SB15
FEEDBACK
FINELY ADJUST MEMS ANGLE
SB16

FIG.12

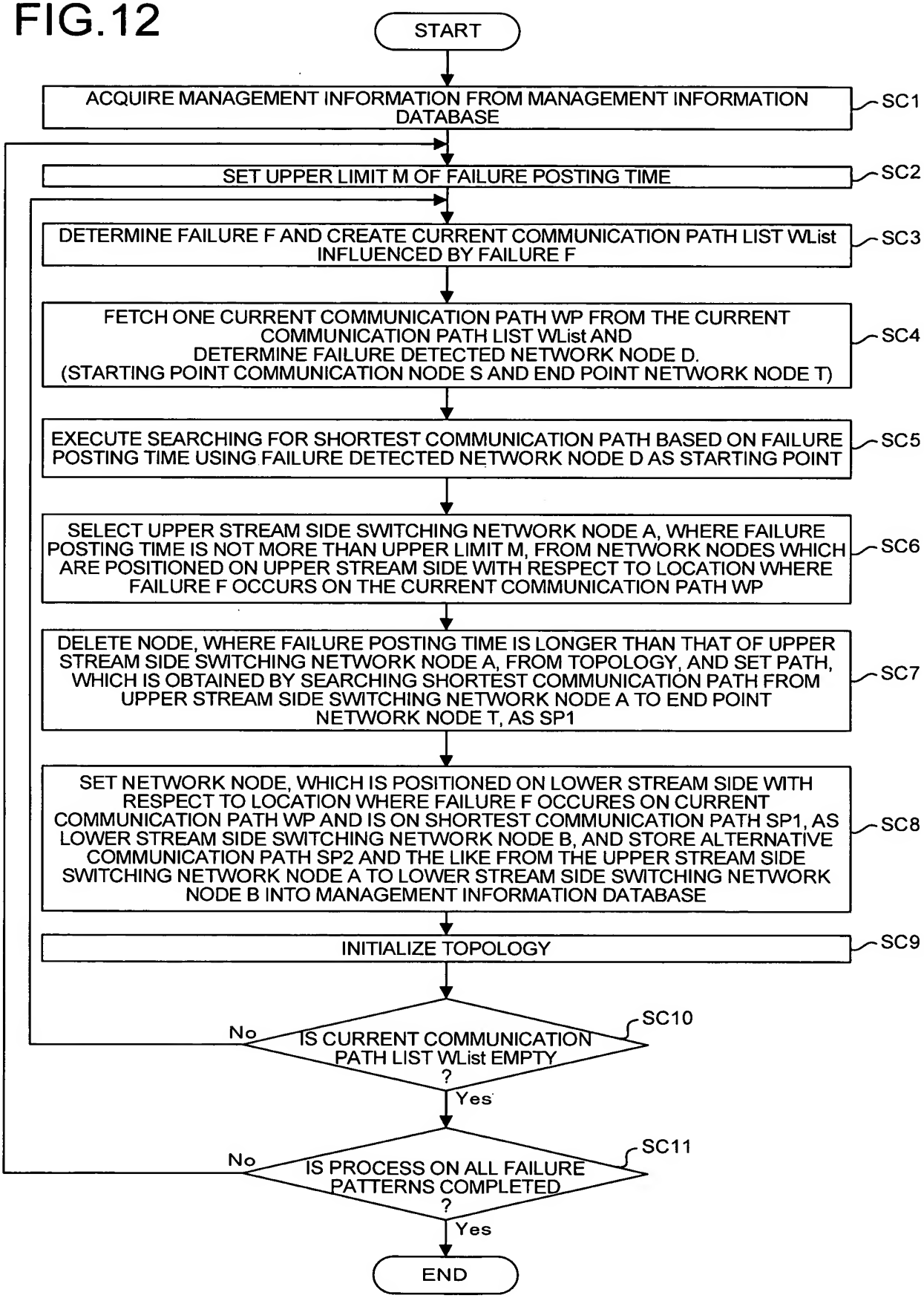

START
ACQUIRE MANAGEMENT INFORMATION FROM MANAGEMENT INFORMATION DATABASE
SC1
SET UPPER LIMIT M OF FAILURE POSTING TIME
SC2
DETERMINE FAILURE F AND CREATE CURRENT COMMUNICATION PATH LIST WList INFLUENCED BY FAILURE F
SC3
FETCH ONE CURRENT COMMUNICATION PATH WP FROM THE CURRENT COMMUNICATION PATH LIST WList AND DETERMINE FAILURE DETECTED NETWORK NODE D. (STARTING POINT COMMUNICATION NODE S AND END POINT NETWORK NODE T)
SC4
EXECUTE SEARCHING FOR SHORTEST COMMUNICATION PATH BASED ON FAILURE POSTING TIME USING FAILURE DETECTED NETWORK NODE D AS STARTING POINT
SC5
SELECT UPPER STREAM SIDE SWITCHING NETWORK NODE A, WHERE FAILURE POSTING TIME IS NOT MORE THAN UPPER LIMIT M, FROM NETWORK NODES WHICH ARE POSITIONED ON UPPER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURS ON THE CURRENT COMMUNICATION PATH WP
SC6
DELETE NODE, WHERE FAILURE POSTING TIME IS LONGER THAN THAT OF UPPER STREAM SIDE SWITCHING NETWORK NODE A, FROM TOPOLOGY, AND SET PATH, WHICH IS OBTAINED BY SEARCHING SHORTEST COMMUNICATION PATH FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO END POINT NETWORK NODE T, AS SP1
SC7
SET NETWORK NODE, WHICH IS POSITIONED ON LOWER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURES ON CURRENT COMMUNICATION PATH WP AND IS ON SHORTEST COMMUNICATION PATH SP1, AS LOWER STREAM SIDE SWITCHING NETWORK NODE B, AND STORE ALTERNATIVE COMMUNICATION PATH SP2 AND THE LIKE FROM THE UPPER STREAM SIDE SWITCHING NETWORK NODE A TO LOWER STREAM SIDE SWITCHING NETWORK NODE B INTO MANAGEMENT INFORMATION DATABASE
SC8
INITIALIZE TOPOLOGY
SC9
IS CURRENT COMMUNICATION PATH LIST WList EMPTY ?
SC10
No
Yes
IS PROCESS ON ALL FAILURE PATTERNS COMPLETED ?
SC11
No
Yes
END

FIG.13

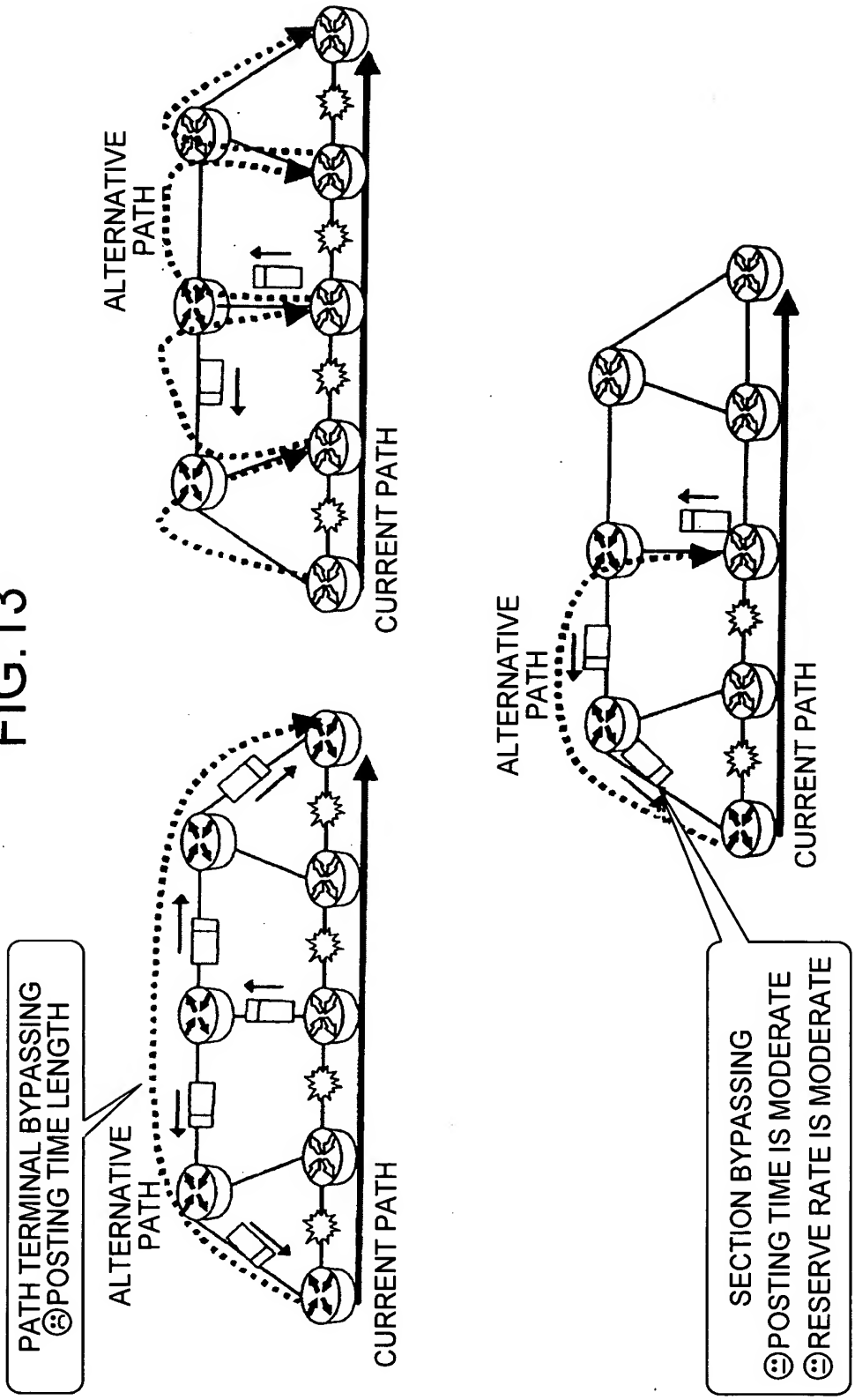

PATH TERMINAL BYPASSING
☹POSTING TIME LENGTH
ALTERNATIVE PATH
CURRENT PATH
ALTERNATIVE PATH
CURRENT PATH
SECTION BYPASSING
😐POSTING TIME IS MODERATE
😐RESERVE RATE IS MODERATE
ALTERNATIVE PATH
CURRENT PATH

FIG.14

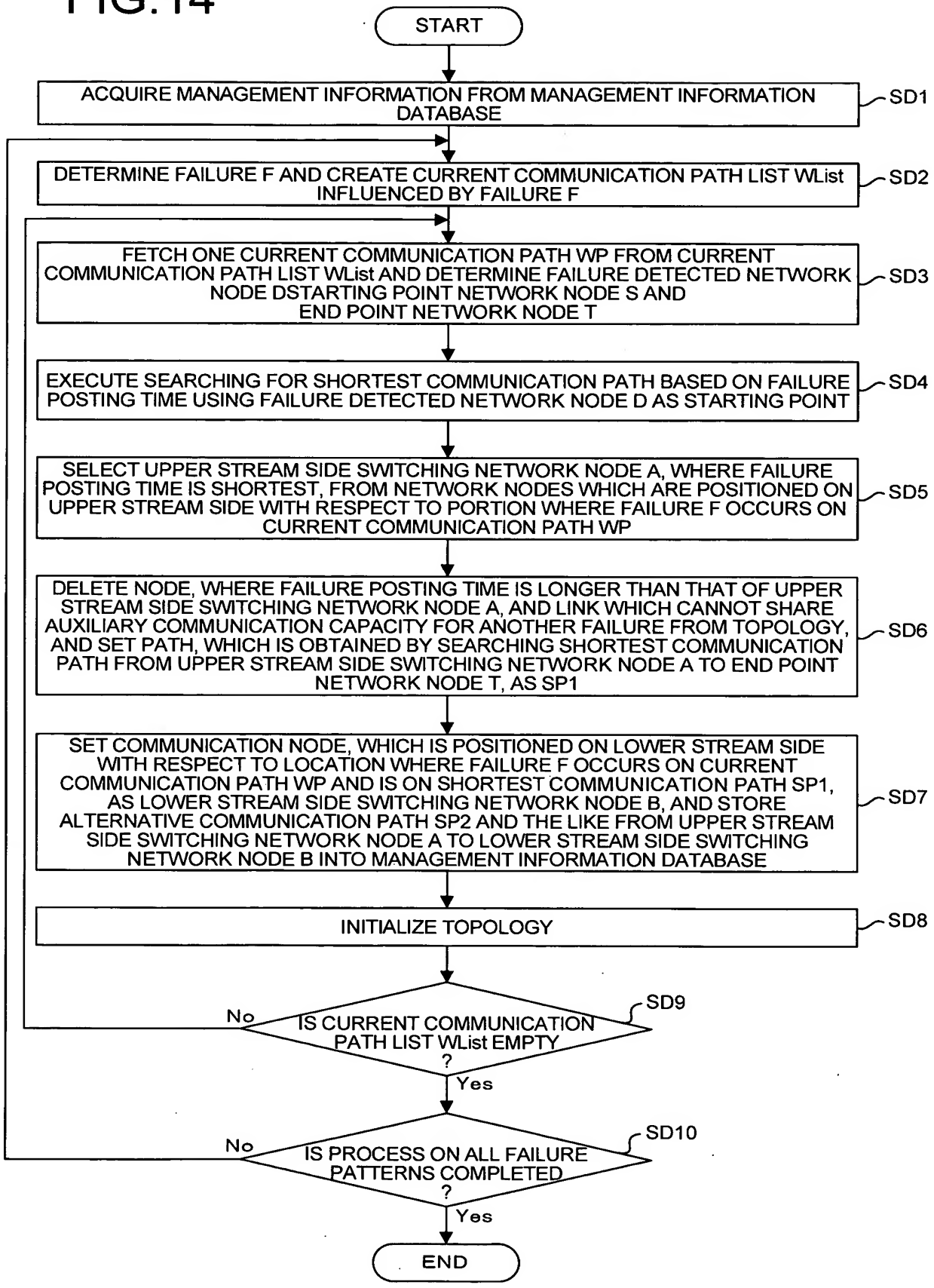

START
ACQUIRE MANAGEMENT INFORMATION FROM MANAGEMENT INFORMATION DATABASE
SD1
DETERMINE FAILURE F AND CREATE CURRENT COMMUNICATION PATH LIST WList INFLUENCED BY FAILURE F
SD2
FETCH ONE CURRENT COMMUNICATION PATH WP FROM CURRENT COMMUNICATION PATH LIST WList AND DETERMINE FAILURE DETECTED NETWORK NODE DSTARTING POINT NETWORK NODE S AND END POINT NETWORK NODE T
SD3
EXECUTE SEARCHING FOR SHORTEST COMMUNICATION PATH BASED ON FAILURE POSTING TIME USING FAILURE DETECTED NETWORK NODE D AS STARTING POINT
SD4
SELECT UPPER STREAM SIDE SWITCHING NETWORK NODE A, WHERE FAILURE POSTING TIME IS SHORTEST, FROM NETWORK NODES WHICH ARE POSITIONED ON UPPER STREAM SIDE WITH RESPECT TO PORTION WHERE FAILURE F OCCURS ON CURRENT COMMUNICATION PATH WP
SD5
DELETE NODE, WHERE FAILURE POSTING TIME IS LONGER THAN THAT OF UPPER STREAM SIDE SWITCHING NETWORK NODE A, AND LINK WHICH CANNOT SHARE AUXILIARY COMMUNICATION CAPACITY FOR ANOTHER FAILURE FROM TOPOLOGY, AND SET PATH, WHICH IS OBTAINED BY SEARCHING SHORTEST COMMUNICATION PATH FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO END POINT NETWORK NODE T, AS SP1
SD6
SET COMMUNICATION NODE, WHICH IS POSITIONED ON LOWER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURS ON CURRENT COMMUNICATION PATH WP AND IS ON SHORTEST COMMUNICATION PATH SP1, AS LOWER STREAM SIDE SWITCHING NETWORK NODE B, AND STORE ALTERNATIVE COMMUNICATION PATH SP2 AND THE LIKE FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO LOWER STREAM SIDE SWITCHING NETWORK NODE B INTO MANAGEMENT INFORMATION DATABASE
SD7
INITIALIZE TOPOLOGY
SD8
IS CURRENT COMMUNICATION PATH LIST WList EMPTY ?
SD9
No
Yes
IS PROCESS ON ALL FAILURE PATTERNS COMPLETED ?
SD10
No
Yes
END

FIG.15

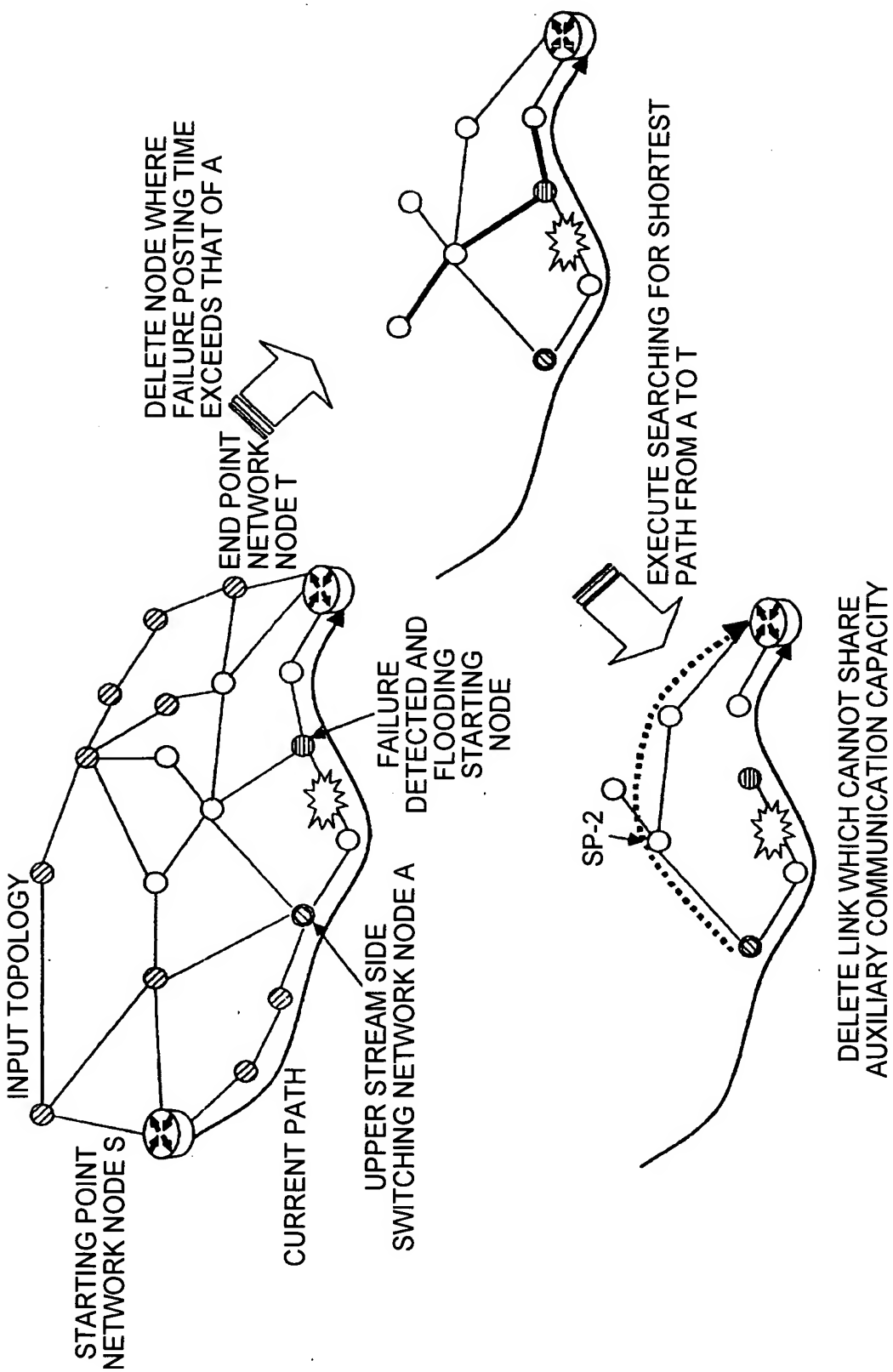

INPUT TOPOLOGY
STARTING POINT NETWORK NODE S
CURRENT PATH
UPPER STREAM SIDE SWITCHING NETWORK NODE A
FAILURE DETECTED AND FLOODING STARTING NODE
END POINT NETWORK NODE T
DELETE NODE WHERE FAILURE POSTING TIME EXCEEDS THAT OF A
EXECUTE SEARCHING FOR SHORTEST PATH FROM A TO T
SP-2
DELETE LINK WHICH CANNOT SHARE AUXILIARY COMMUNICATION CAPACITY

FIG.16

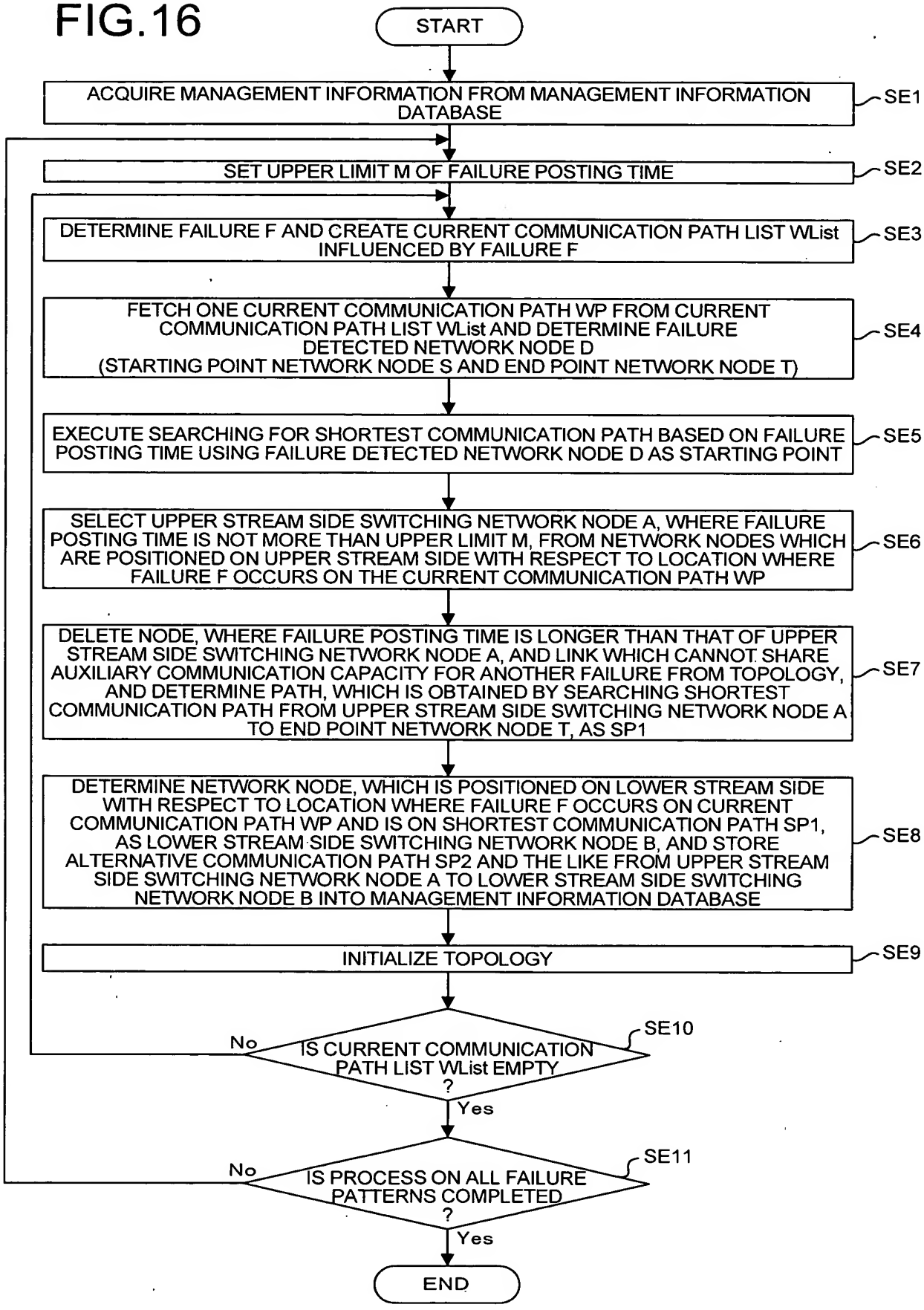

START
ACQUIRE MANAGEMENT INFORMATION FROM MANAGEMENT INFORMATION DATABASE
SE1
SET UPPER LIMIT M OF FAILURE POSTING TIME
SE2
DETERMINE FAILURE F AND CREATE CURRENT COMMUNICATION PATH LIST WList INFLUENCED BY FAILURE F
SE3
FETCH ONE CURRENT COMMUNICATION PATH WP FROM CURRENT COMMUNICATION PATH LIST WList AND DETERMINE FAILURE DETECTED NETWORK NODE D (STARTING POINT NETWORK NODE S AND END POINT NETWORK NODE T)
SE4
EXECUTE SEARCHING FOR SHORTEST COMMUNICATION PATH BASED ON FAILURE POSTING TIME USING FAILURE DETECTED NETWORK NODE D AS STARTING POINT
SE5
SELECT UPPER STREAM SIDE SWITCHING NETWORK NODE A, WHERE FAILURE POSTING TIME IS NOT MORE THAN UPPER LIMIT M, FROM NETWORK NODES WHICH ARE POSITIONED ON UPPER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURS ON THE CURRENT COMMUNICATION PATH WP
SE6
DELETE NODE, WHERE FAILURE POSTING TIME IS LONGER THAN THAT OF UPPER STREAM SIDE SWITCHING NETWORK NODE A, AND LINK WHICH CANNOT SHARE AUXILIARY COMMUNICATION CAPACITY FOR ANOTHER FAILURE FROM TOPOLOGY, AND DETERMINE PATH, WHICH IS OBTAINED BY SEARCHING SHORTEST COMMUNICATION PATH FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO END POINT NETWORK NODE T, AS SP1
SE7
DETERMINE NETWORK NODE, WHICH IS POSITIONED ON LOWER STREAM SIDE WITH RESPECT TO LOCATION WHERE FAILURE F OCCURS ON CURRENT COMMUNICATION PATH WP AND IS ON SHORTEST COMMUNICATION PATH SP1, AS LOWER STREAM SIDE SWITCHING NETWORK NODE B, AND STORE ALTERNATIVE COMMUNICATION PATH SP2 AND THE LIKE FROM UPPER STREAM SIDE SWITCHING NETWORK NODE A TO LOWER STREAM SIDE SWITCHING NETWORK NODE B INTO MANAGEMENT INFORMATION DATABASE
SE8
INITIALIZE TOPOLOGY
SE9
IS CURRENT COMMUNICATION PATH LIST WList EMPTY ?
SE10
No
Yes
IS PROCESS ON ALL FAILURE PATTERNS COMPLETED ?
SE11
No
Yes
END

FIG.17

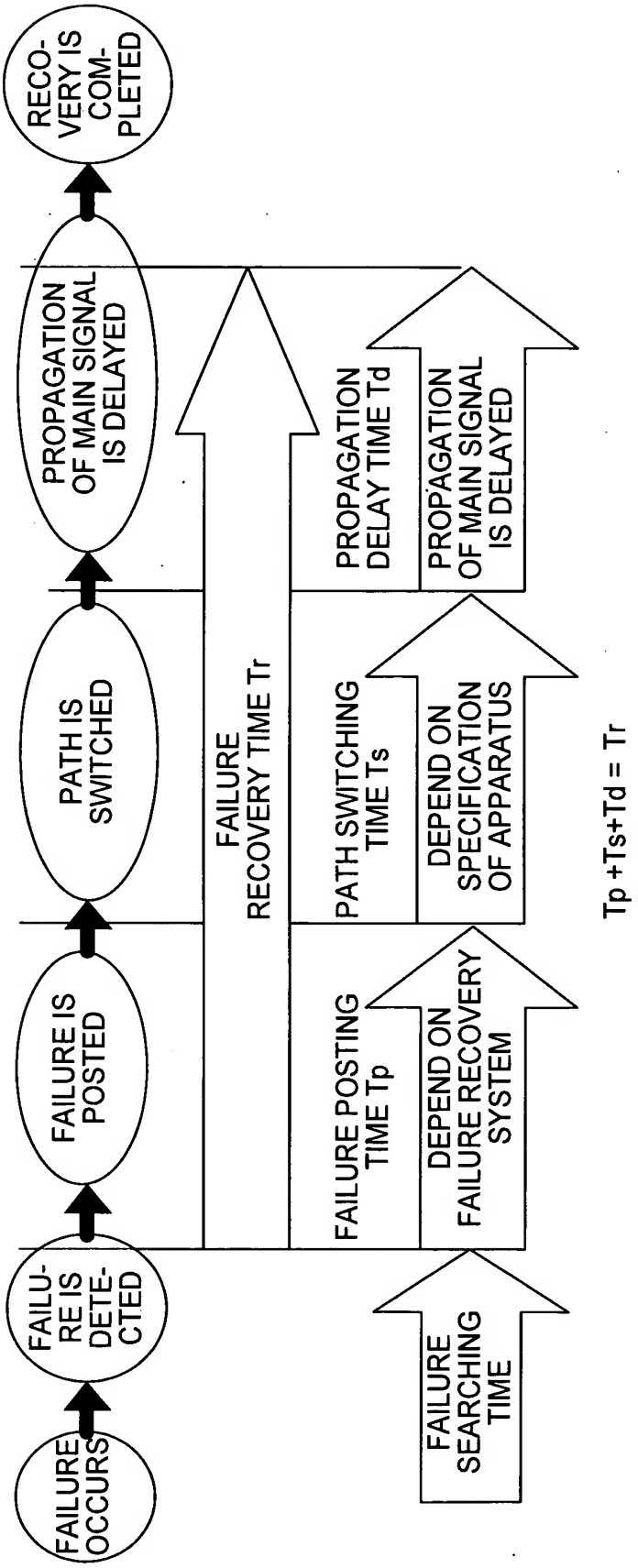

FAILURE OCCURS
FAILU-RE IS DETE-CTED
FAILURE IS POSTED
PATH IS SWITCHED
PROPAGATION OF MAIN SIGNAL IS DELAYED
RECO-VERY IS COM-PLETED
FAILURE RECOVERY TIME Tr
FAILURE SEARCHING TIME
FAILURE POSTING TIME Tp
DEPEND ON FAILURE RECOVERY SYSTEM
PATH SWITCHING TIME Ts
DEPEND ON SPECIFICATION OF APPARATUS
PROPAGATION DELAY TIME Td
PROPAGATION OF MAIN SIGNAL IS DELAYED
Tp +Ts+Td = Tr

FIG.18

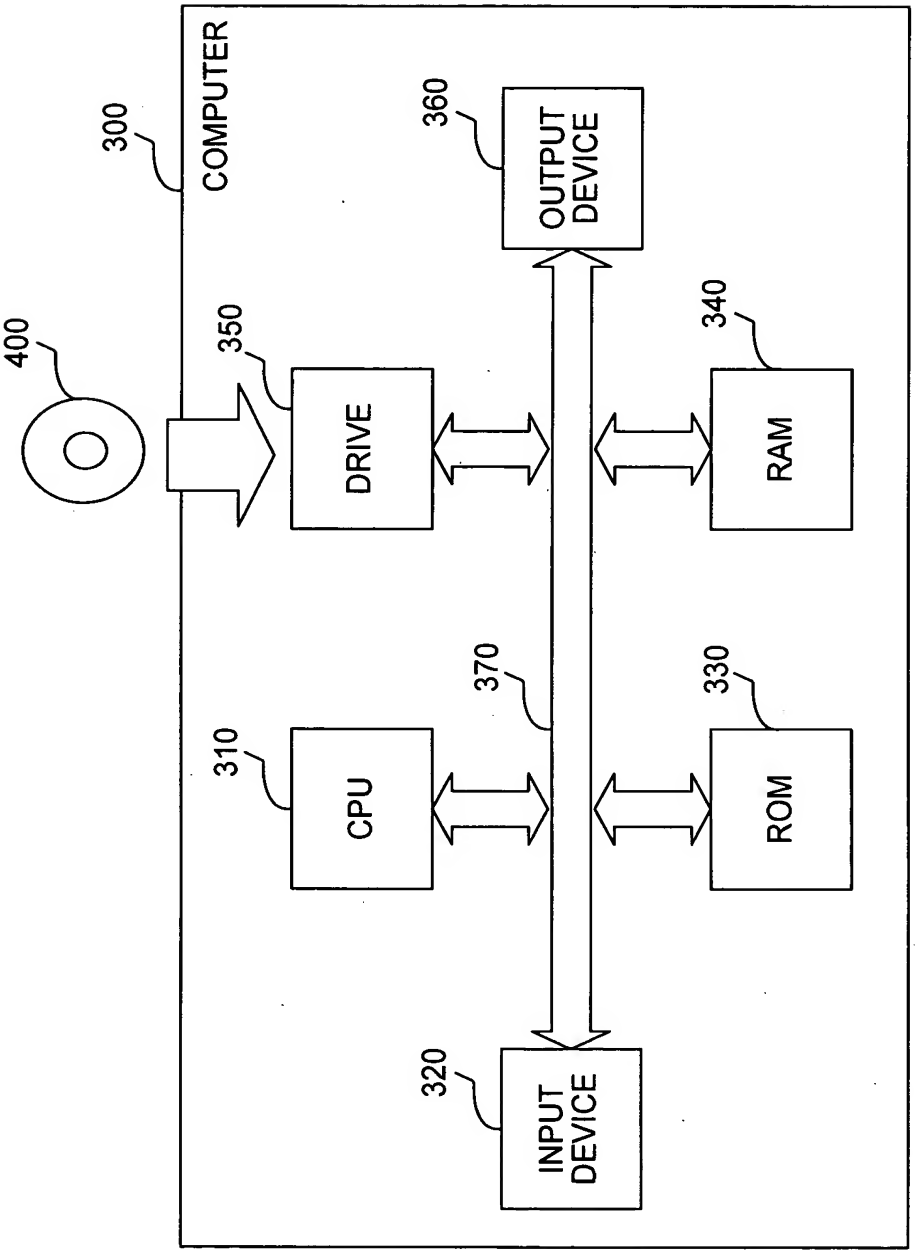
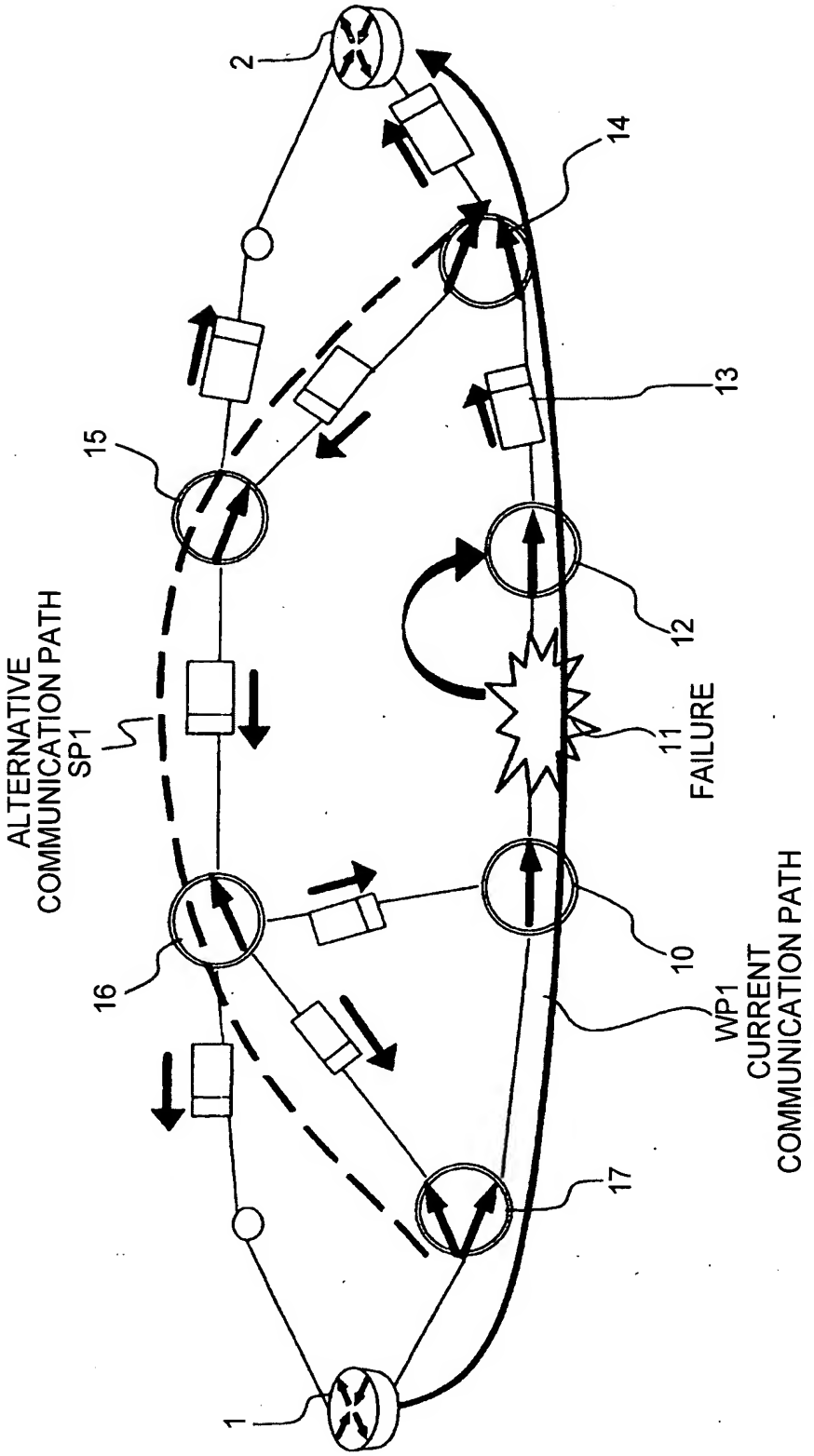

300
COMPUTER
360
OUTPUT DEVICE
400
350
DRIVE
340
RAM
370
310
CPU
330
ROM
320
INPUT DEVICE

FIG.19


1
2
10
11
12
13
14
15
16
17
ALTERNATIVE COMMUNICATION PATH SP1
FAILURE
WP1 CURRENT COMMUNICATION PATH